Suicide-associated comorbidity among US males and females: a multiple cause-of-death analysis

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Objective: To describe physical and mental comorbidity among male and female suicides in the US. This research replicates a seminal Australian study, which permits inference on comparative cause-of-death data quality.

Design and setting: National cross-sectional study of suicides and unintentional injury decedents (comparison group) using Multiple Cause of Death (MCOD) public use files for 1999–2003.

Main outcome measures: Prevalence of medical conditions; relative odds of suicide-associated comorbidity.

Results: For 14% of male suicides and 19% of female suicides, comorbidity was shown on their death certificates. Respective prevalences for mental and physical comorbidity were 7.2% and 7.1% for males and 10.0% and 9.3% for females. Mean numbers of psychopathologies mentioned were virtually identical for male and female suicides (1.22 and 1.21) for whom comorbidity was registered. Mean mentions of physical disease were lower for male suicides: 1.64 vs 1.77. Multiple medical conditions were registered for 4% of male suicides and 6% of female suicides. Suicides manifested excess comorbidity for depression and mood disorders (adjusted odds ratio (AOR)=34.6, 95% CI=32.41 to 36.92), schizophrenia (AOR=2.5, 95% CI=2.16 to 2.88), and cancer (AOR=2.1, 95% CI=1.93 to 2.19), but unexpectedly no excess comorbidity for HIV.

Conclusions: The US system of death certification appears to be less fastidious than the Australian system. Although comorbidity patterns were very similar, only half as much psychopathology was reported for US suicides as for Australian suicides. A questionable deficit of comorbid physical disease was also documented for US suicides. Findings have important implications for medical training, as well as for suicide surveillance, policy, and prevention.

D espite the proneness of suicide to underenumeration,[1–3] the suicide rate qualifies as a leading candidate to index national misery in economically advanced democratic societies, along with such economic indicators as unemployment and inflation rates[4] and psychosocial variables such as prevalence of substance abuse and the divorce rate. During the 1999–2003 quinquennium, suicide accounted for more years of potential life lost among Americans before the age of 65 than homicide, HIV, congenital anomalies, stroke, and liver disease.[5] It ranked among the top 10 causes of death from ages 10 to 65 years. Suicide is also highly problematic in the geriatric population, specifically the male segment.

American suicidologists have largely restricted their death analyses to the Mortality Detail Files.[6] In so doing, they have neglected the national Multiple Cause of Death (MCOD) files, which contain information on both mental and physical health impairments among those who have committed suicide. Salient to suicide risk group delineation and design and implementation of suicide-prevention programs, these medical conditions can hold etiologic significance.[7–10] Some researchers have noted value in employing MCOD data to cross-classify nature of injury, such as asphyxiation or laceration, and external cause of injury, such as suicide or train crash.[11–13] Typically, however, injury has only been peripherally analysed with these data.

Australian researchers were the first to employ MCOD data in a national suicide study.[14] They documented the prevalence of comorbid medical disorders among completed suicides for the period 1999–2001. Besides generating descriptive data, their seminal study incorporated an analytic component in which associations between suicide and various comorbidities were evaluated. In the absence of a suitable general population sample, the Australians chose unintentional injury decedents as

their comparison or control group. This choice rested on similarities in the nature and intensity of medicolegal investigations of suicide and unintentional injury mortality cases. These similarities also motivated use of this type of comparison group in studies of psychopathologic determinants of suicide in the US black and white populations and psychopathologic and other suicide determinants in Norwegian military peacekeepers.[15 16]

A quarter of Australian male suicides and a third of female suicides had at least one mention of comorbidity on their death certificates; 12% of the males and 17% of the females had two or more mentions.[14] As a percentage of total comorbid mentions, psychopathologic conditions were more prevalent than physical disease among suicides independent of sex: 55% for males and 57% for females. Respective prevalences of depression and mood disorders, alcohol disorders, and other substance use disorders among male suicides with comorbid psychopathology were 40%, 27%, and 17%. Corresponding female figures were 54%, 16%, and 10%. Overall prevalence of comorbidity among male suicides was 79% of that for female suicides. The Australian researchers did not report mean numbers of comorbid mentions for suicides for whom comorbidity was documented. However, on the basis of calculations using their data, the means were 1.27 and 1.25 for males and females, respectively. Corresponding means for comorbid physical disease were 1.85 and 2.16. Physical disease comorbidity predominated among elderly suicides and psychopathologic comorbidity among their younger counterparts. Comorbid alcohol and other substance use disorders were less prevalent among suicides than among unintentional injury decedents. Adjusting for age and sex in a series of logistic regression analyses, the Australian team linked suicide to the

following comorbidities: depression and mood disorders (adjusted odds ratio (AOR) = 7.43; 95% CI = 6.64 to 8.31), schizophrenia (AOR = 2.66; 95% CI = 2.21 to 3.19), other mental disorders exclusive of organic disease (AOR = 2.78; 95% CI = 2.23 to 3.46), and cancer (AOR = 1.85; 95% CI = 1.59 to 2.16).

Although the US population is 14 times larger than the Australian population, their suicide rates are equivalent. In 2003, the US suicide rate was 10.8 per 100 000 compared with 11.1 for Australia.[5 17] Respective male and female rates were 17.6 and 4.3 per 100 000 for the US and 17.7 and 4.7 for Australia. This research replicates the Australian MCOD suicide study in first estimating the prevalence of medical conditions among US male and female suicides, and then identifying their suicide-associated comorbidity.[14] Methodological differences in these two studies are minor, most notably involving the respective range and disaggregation of decedent age. Fifteen years was the minimum age cutoff in this study and 10 in the Australian study. Enabled by a much larger cohort, another difference was that in this study HIV could be separated from other communicable disease for purposes of identifying suicide-associated comorbidities.

The present study is based on the general population, and incorporates all deaths from suicide over a 5-year period. This is in contrast with most previous research which is based on local samples of predominantly patient populations.[7 8] The latter set of studies generate results that may not replicate to a national sample of all persons who died by suicide, as opposed to the subset who are undergoing or underwent psychiatric or related therapy. In addition, the present investigation weighs the importance of somatic disease against mental illness in the etiology of suicide. Most previous research has been restricted to one or the other, and many investigations have been confined to a single somatic disease such as cancer or HIV.

DATA AND METHODS

The data source was the MCOD public use files produced by the National Center for Health Statistics. Causes of death were precoded under the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (ICD-10).[18] The study group (n = 151 183) and comparison group (n = 488 574) originated from persons dying at ages 15 years or older in the 50 states and the District of Columbia during the period 1999–2003. The 52 suicide cases with missing ages were also excluded. Age 15 was the minimum age cutoff because suicide is rare among children and younger teens[19]—less than 1% of all suicides during the observation period. The study group was further confined to decedents whose underlying cause of death was intentional self-harm (X60–X84.9) or sequelae of intentional self-harm (Y87.0), and the comparison group to decedents whose underlying cause of death was unintentional injury (VO1–X59) or its sequelae (Y85–Y86). A timely ruling by medicolegal authorities of a death as suicide almost invariably means that suicide becomes the official underlying cause of

Table 2 Prevalence of medical conditions in suicide and unintentional injury decedents by age and sex: United States, 1999–2003

Medical condition (ICD-10 code)	Suicide			Unintentional injury		
	15–34	35–64	65+	15–34	35–64	65+
Males						
Number of deaths	37708	60938	22833	101767	135847	80644
Mental/behavioral disorders	7.7%	9.8	6.6	8.9%	15.2	7.6
Organic (F00–F09)	0.1	0.1	0.2	0.0	0.1	4.5
Alcohol use (F10)	2.2	3.1	0.7	4.7	7.7	1.7
Other substance use (F11–F19)	0.9	0.8	0.2	3.9	6.7	0.7
Schizophrenia (F20–F29)	0.4	0.3	0.1	0.1	0.2	0.1
Depression/mood disorder (F30–F39)	3.8	5.3	5.3	0.1	0.2	0.4
Other mental health (F40–F99)	0.3	0.3	0.2	0.1	0.2	0.2
Physical diseases	6.1	9.5	19.2	12.5	32.5	92.8
HIV (B20–B24)	0	0.1	0	0	0.2	0
Other communicable (A+B residual)	0.1	0.2	0.2	0.4	1.6	3.9
Cancer (C00–C99)	0	0.6	4.9	0.1	0.5	3.2
Nervous system (G00–G99)	2	1.5	1.6	1.6	2.3	6.5
Circulatory (I00–I99)	1.3	2.8	6.1	3.6	11.8	33.9
Respiratory (J00–J99)	0.5	0.9	2.7	2.1	4.8	21.6
Digestive (K00–K99)	0.3	0.7	0.5	0.5	2.9	2.5
Other diseases (D,E,H,L–R)	1.9	2.6	3.2	4.2	8.4	21.2
Total disorders and diseases	13.8	19.3	25.9	21.4	47.7	100.4
Females						
Number of deaths	7370	18159	4175	33378	53260	83678
Mental/behavioral disorders	10.1%	13.0	9.6	6.5%	12.2	9.6
Organic (F00–F09)	0.1	0.1	0.3	0	0.2	7.5
Alcohol use (F10)	2	3.4	1.1	2.6	4.7	0.5
Other substance use (F11–F19)	1.3	1.2	0.8	3.4	6	0.5
Schizophrenia (F20–F29)	0.4	0.4	0.2	0.1	0.3	0.2
Depression/mood disorder (F30–F39)	5.8	7.5	6.8	0.2	0.7	0.7
Other mental health (F40–F99)	0.5	0.4	0.4	0.2	0.3	0.3
Physical diseases	9.5	14.6	21.9	13.5	37.6	103.6
HIV (B20–B24)	0	0	0	0.1	0.2	0
Other communicable (A+B residual)	0.2	0.5	0.4	0.5	1.9	4.2
Cancer (C00–C99)	0.1	0.7	2.5	0.1	0.8	2.3
Nervous system (G00–G99)	2.5	2	2	1.8	3.2	6.6
Circulatory (I00–I99)	1.6	3.9	7.6	3.2	11.6	38.5
Respiratory (J00–J99)	1	1.8	3.5	2.3	5.8	21.7
Digestive (K00–K99)	1.4	1.4	0.9	0.6	3.2	2.8
Other diseases (D,E,H,L–R)	2.7	4.3	5.2	5	10.9	27.4
Total disorders and diseases	19.6	27.7	31.5	20	49.8	113.2

Age groups were 15–34, 35–64, and 65+.

death.[11] National data for 2001–2002 showed 99% concordance between a suicidal mention on the death certificate and its assignment as the underlying cause of death.[20] Pertinent to selecting an appropriate comparison group, suicides and unintentional injury mortality cases were assumed to induce investigations of a similar nature and intensity.

Record axis codes were used rather than the alternative entity axis codes because they identify the underlying cause of death but disregard the order and location of all other conditions mentioned on the death certificate.[21] This is consistent with mortality data used in the Australian study.[14 22] Bivariate and multivariate analyses were performed. Prevalence calculations drew upon all potential comorbid mentions on the death certificate, up to 20. Only one condition was counted when more than one was associated with a particular mental disorder or physical disease category. Outcome variables in a series of multiple logistic regression analyses were the six categories of mental disorders and eight categories of physical disease also utilized in the bivariate analyses. Odds ratios were adjusted for age and sex. MCOD data permit documentation of possible etiologic associations between comorbidity and suicide. Given the typically acute nature of injury mortality, it is assumed that any comorbidity enumerated on the death certificates of the subjects in this study is antecedent although not necessarily causal. SAS (version 9.13; Cary, North Carolina, USA) was the computer package used for the statistical analyses.

RESULTS
Prevalence of comorbidity
Distinguishing the sexes, table 1 (available online at http://ip.bmj.com/supplemental) summarizes the multiple entries on the death certificates of suicides that cover nature of injury and comorbid mental disorders and physical diseases. In the US during the observation period, 1999–2003, there were approximately 121 000 male suicides and 30 000 female suicides aged 15 years and older at time of death. There was within-gender equivalence in the relative distribution of at least one mention of either psychopathology or physical disease on their death certificates. However, greater comorbidity was evident among female suicides. For approximately one in five female suicides and one in seven male suicides, some form of medical disorder was registered. Respective prevalences for mental and physical comorbidity were 7.2% and 7.1% for males and 10.0% and 9.3% for females. As a percentage of total mentions on death certificates of suicides, psychopathologic conditions were less prevalent than physical disease: 43% for males and 42% for females. The prevalence of depression and mood disorders, alcohol disorders, and other substance use disorders among male suicides with comorbid psychopathology was 56%, 28%, and 9%. Corresponding female figures were 59%, 23%, and 10%. Mean numbers of comorbid mentions among suicides in this group were approximately equivalent for males and females: 1.22 and 1.21, respectively. The corresponding mean for suicides with comorbid physical disease was lower for males: 1.64 vs 1.77. Mean total number of comorbid mentions was 1.43 for male suicides and 1.48 for female suicides. For 4% of male suicides and 6% of female suicides, two or more comorbidities were registered on the death certificates.

Table 2 reports age-specific and sex-specific prevalences of MCOD entries for decedents classified under suicide or unintentional injury. The prevalence of physical disease comorbidity increased monotonically with age for deaths from both suicide and unintentional injury. In contrast, the age-specific prevalence of psychopathologic comorbidity was curvi-linear. Depression and mood disorders predominated among suicides of all ages, and alcohol and other substance use disorders among unintentional injury decedents aged 15–64 years. Unlike corresponding suicides, older unintentional injury decedents manifested a high prevalence of organic mental illness. Irrespective of gender, the overall prevalence of comorbidity for unintentional injury decedents was more than double that for suicides. Of suicides with records of either alcohol or other substance use problems, 34% of males and 28% of females had additional psychopathology, principally depression and a substance use disorder (data not shown). Of suicides for whom an alcohol use disorder was registered, corresponding prevalences were 28% for males and 24% for females. For suicides with other substance use disorders, the prevalence of additional psychopathology was 53% for males and 39% for females.

Suicide-associated comorbidity
Table 3 presents the results of the unconditional logistic regression analyses that were performed to calculate the odds that a suicide, relative to an unintentional injury decedent, manifested a given comorbidity. Three categories of comorbid psychopathology and one category of physical disease showed excess likelihood of being recorded on the death certificates for suicides relative to those for unintentional injury decedents. They were depression and mood disorders, schizophrenia, a residual non-organic mental health category, and cancer. Suicides manifested a lower likelihood than the comparison group for all other comorbid mentions. Although odds ratios were adjusted for age and sex, a sensitivity analysis produced similar results in the absence of that adjustment. Of the medical disorders under review, only the results for HIV comorbidity were modified by the sensitivity analysis. HIV was no longer associated with death by suicide, whereas previously there was a negative association.

DISCUSSION
US and Australian comparisons
A complex phenomenon, suicide has a multifactorial etiology.[6–8 23] Comorbidity can be one determinant. MCOD data afford researchers the opportunity to document comorbidity among large numbers of suicides at sub-national as well as national levels. Distinguishing sex and age, this is the first study to profile comorbidity among US suicides and report their suicide-associated comorbidity. Instructive critical comparisons are permitted because it replicates an Australian study,[14] and the US and Australia share similar suicide rates and levels of

Table 3 Logistic regression results for suicide-associated comorbidities: United States, 1999–2003

Medical condition (ICD-10 code)	Odds ratio (95% CI (Wald))
Mental/behavioral disorders	
Organic (F00–F09)	0.12 (0.096 to 0.137)
Alcohol use (F10)	0.45 (0.428 to 0.462)
Other substance use (F11–F19)	0.16 (0.149 to 0.169)
Schizophrenia (F20–F29)	2.49 (2.157 to 2.875)
Depression/mood disorder (F30–39)	34.59 (32.414 to 36.916)
Other mental health (F40–F99)	1.67 (1.448 to 1.925)
Physical diseases	
HIV (B20–B24)	0.67 (0.516 to 0.867)
Other communicable (A+B residual)	0.21 (0.184 to 0.234)
Cancer (C00–C99)	2.06 (1.929 to 2.191)
Nervous system (G00–G99)	0.78 (0.751 to 0.821)
Circulatory (I00–I99)	0.23 (0.222 to 0.237)
Respiratory (J00–J99)	0.22 (0.210 to 0.232)
Digestive (K00–K99)	0.58 (0.540 to 0.622)
Other diseases (D,E,H,L–R)	0.33 (0.317 to 0.341)

Odds ratios are adjusted for age and sex. Unintentional injury decedents served as the referent.

socioeconomic development. The bivariate data from these two studies show both demographic and diagnostic parallels in reported comorbidities among suicides. Although our three broad age groups depart slightly from those used in the Australian study, they combine the more refined age groups commonly used in US mortality studies. The identical suicide-associated comorbidities that emerge from comparison of the results of the US and Australian multivariate analyses are a particularly striking finding. They are depression and mood disorders, schizophrenia, a residual non-organic mental health category, and cancer. These alignments suggest that MCOD data may be robust enough to support cross-national analytic research on suicide, at least for democratic industrialized countries.

Cancer was the only physical disease category of comorbidity that was associated with suicide mortality in the US and Australian studies. This cancer finding is unsurprising in the light of a meta-analysis of disease-associated suicide risk factors and two studies of terminally ill cancer patients.[7 24 25] The association between cancer and suicide risk has been interpreted from the perspective of pain as a risk factor.[26] Other major causes of death, such as heart disease and stroke, are not generally marked by chronic pain. The aforementioned meta-analysis showed a positive association between HIV and suicide risk, a finding not affirmed in this study. Although it requires in-depth research, a plausible explanation for the difference is that effective antiretroviral therapy has altered the mindset of those who have tested HIV positive, relative to that of their predecessors, because of the empirically backed promise of prolonged survival.[27 28] The meta-analysis incorporated HIV studies that were mostly conducted on patient samples during a period when an HIV diagnosis implied a shorter-term death sentence. To reiterate, the Australian researchers did not isolate HIV from other communicable disease for their multivariate analyses of suicide-associated comorbidity.

Profound variation surfaces in the magnitude of comorbidity among suicides reported in the US and Australian MCOD studies. Psychopathology is over twice as prevalent among Australian as American suicides, inferring that US suicide data are less comprehensive in cause-of-death documentation. Reinforcing this inference is the fact that Australia surpasses the US in both life expectancy and healthy life expectancy at birth.[29] As it quantifies quality of life, healthy life expectancy is arguably the more germane of these two measures in the current context. In 2002, it was estimated to be 72.6 years for Australians and 69.3 years for Americans. This estimation incorporated psychopathologic conditions, including substance use disorders. Less evidence of physical disease among American than Australian suicides further reinforces the

inference that US suicide data are less comprehensive in their cause of death documentation than Australian data.

Limitations in MCOD data

MCOD suicide data in Australia are not a gold standard for the US. In both countries, these data probably fall short of capturing the true prevalence of psychopathology among suicides. A psychological autopsy study, conducted in New Brunswick, Canada, found that 65% of suicides manifested a comorbid mood disorder, 59% a comorbid substance use disorder, and 42% both of these disorders.[30] A review of seven psychological autopsy studies targeting adolescent suicides and drawn from four different countries, including the US, showed comorbid psychopathology ranging from 28% to 95%.[31] The prevalence of substance use disorders, a subset of psychopathology, ranged from 12% to 62%. Findings from other studies that implicate substance abuse as a risk factor for both suicide and unintentional injury mortality[30 32 33] provide a caveat for researchers using unintentional injury decedents as the comparison group in measuring suicide-associated comorbidity. The magnitude of the odds ratios generated in the multivariate analyses of suicide-associated comorbidity were generally very similar in the US and Australian studies. A major exception occurred with depression and mood disorders, where the respective magnitudes were 35 and 7. This gross discrepancy, together with a higher prevalence of psychopathology among Australian suicides, suggests that Australian medicolegal authorities are more fastidious than American counterparts in assessing psychiatric disorders among their fatal injury cases.

Documentation of both psychiatric and non-psychiatric comorbidity may be more sensitive and comprehensive for female than male suicides in the US and Australia. Focusing on the US, females utilize more health services than males.[34] Thus, the gender comorbidity differential apparent among US suicides could be a partial or total artifact of more complete diagnostic reporting on death certificates for females. Pertinent to data quality, future research will disaggregate suicides to consider the question of whether minority populations manifest similar or divergent patterns of comorbidity from non-Hispanic whites, and by extension from Australian suicides. Confined to underlying cause-of-death data, a computer simulation suggested that suicide among black people is much more prone to underenumeration than suicide among white people.[35] If valid, an important contributor could be heterogeneity in documentation of medical histories.

Implications for prevention

Authorities charged with ruling whether a given death is a suicide or non-suicide may be facilitated or impeded by the degree of medical history that they can access on the decedent. In response to persisting major deficiencies in death certification generally, there are calls in the US to provide medical students, medical residents, medical examiners, and coroners with appropriate training.[36–39] A prediction is that such training would generate more accurate and comprehensive comorbidity data on suicides and other decedents irrespective of their sociodemographic background. In turn, higher-quality MCOD data would assist researchers, policymakers, and interventionists in matching suicide-prevention efforts with vulnerable groups nationally, and also at state and county levels. They would fortify the evidence base that is so crucial for enlisting the support of legislators, public health professionals, and concerned citizenry in creating and implementing targeted interventions.

Key points

- Female suicides have more comorbid physical and mental disorders on their death certificates than male counterparts.
- The association between suicide and HIV as a risk factor may have been modified over time.
- Multiple cause-of-death data appear robust enough for cross-national analytic research on suicide.
- International variation in documentation of the prevalence of comorbidity among suicides can have important implications for medical training and suicide surveillance, policy, and prevention.

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Competing interests: None.

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